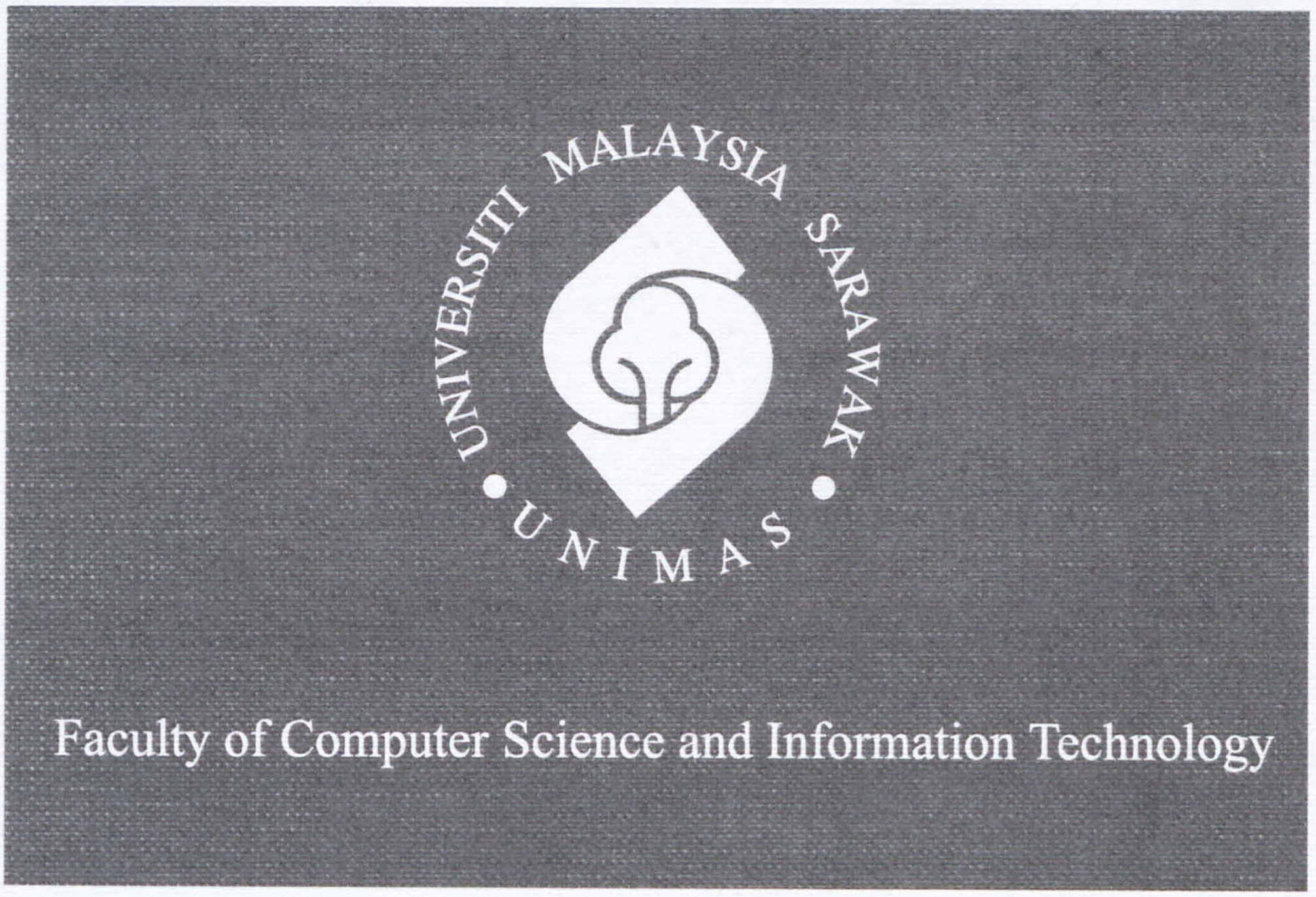

AN OFFLINE EMAIL IMPLEMENTATION BASED ON DELAY TOLERANT NETWORK (DTN)

Mohd Khairun Nasir Bin Sa'adi

Master of Advanced Information Technology
2013

UNIVERSITI MALAYSIA SAWARAK

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Final Year Project Report ☐

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AN OFFLINE EMAIL IMPLEMENTATION BASED ON DELAY TOLERANT NETWORK (DTN)

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A thesis submitted

In fulfillment of the requirements for the Master of Advanced Information Technology

Faculty of Computer Science and Information Technology
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"This thesis is dedicated to my mom and dad, who was giving the infinite support and also to my wife, brothers and sisters who always giving encouragement"

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Advice and support from families also help in the completion of this thesis as well as help from friends who incessantly give guidance and knowledge to me.

ABSTRACT

This thesis focuses on extending offline email system in a local area network environment to the internet connected email system in online environment based on delay tolerant network. This offline email system will allow the rural users to have an access to the internet connected email system. It allows the user to read, write and send email in an offline local network environment. This offline email system will be able to connect to online email system via infomediary device based on delay tolerant network concept. Even though in an offline environment, user also able to read, write and send email as if he or she is in an online environment. This offline email system will allow the email flow through the offline environment to the online environment and vice versa. The most important part of this offline email system is an implementation of email database synchronization between offline mail server and infomediary device and between online mail server and infomediary device. Another part is an implementation of offline and online email system consist of mail server and mail client for both sides. This offline email system will be using operating system Windows XP 32bit, wireless local area network, and internet connection 1MB/s TMnet Streamyx Dynamic IP with the conjunction of *Uniform Server* for personal home server. This offline email system consists of offline mail client, offline mail server, database synchronization at offline server, infomediary device, online mail client, online mail server and database synchronization at online server.

ABSTRAK

Tesis ini memberi tumpuan ke atas melanjutkan sistem emel luar talian dalam persekitaran rangkaian kawasan tempatan ke sistem emel bersambungan internet dalam persekitaran dalam talian berdasarkan rangkaian toleransi kelewatan. Sistem emel luar talian ini akan membolehkan pengguna luar bandar untuk mempunyai akses kepada sistem emel yang bersambungan internet. Ia membolehkan pengguna untuk membaca, menulis dan menghantar emel dalam persekitaran rangkaian kawasan tempatan luar talian. Sistem emel luar talian ini akan boleh menyambung ke sistem emel dalam talian melalui alat informediari berdasarkan konsep rangkaian toleransi kelewatan. Walaupun dalam persekitaran luar talian, pengguna juga boleh membaca, menulis dan menghantar emel seolah-olah dia berada dalam persekitaran dalam talian. Sistem emel luar talian ini akan membolehkan aliran emel melalui persekitaran luar talian ke persekitaran dalam talian dan sebaliknya. Bahagian yang paling penting dalam sistem emel ini adalah perlaksanaan penyegerakan pangkalan data emel antara pelayan mel luar talian dan alat informediari dan antara pelayan mel dalam talian dan alat informediari. Sebahagian yang lain adalah perlaksanaan sistem emel luar talian dan dalam talian yang terdiri daripada pelayan mel dan klien mel untuk kedua-dua pihak. Sistem emel luar talian ini akan menggunakan sistem operasi Windows XP 32 bit, rangkaian kawasan tempatan tanpa wayar dan sambungan internet 1MB/s TMNet Streamyx IP Dinamik bersama dengan *Uniform Server* untuk pelayan rumah peribadi. Sistem emel luar talian ini terdiri daripada klien mel luar talian, pelayan mel luar talian, penyegerakan pangkalan data di pelayan luar talian, alat informediari, klien mel dalam talian, pelayan mel dalam talian dan penyegerakan pangkalan data di pelayan dalam talian.

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1. INTRODUCTION

1.1 Overview

Email application has been commonly used as one of the communication tools which are cheap and easy to use as long as the person has internet connection. Email application is tolerant to delay and the email sender and recipient not required to be online at the same time. Email is suitable especially for those who not in urgency and delay in sending and receiving is acceptable. For those who live in the rural area without the Internet connection, even the application such as an email application is impossible. Rural area such as Bario has a telecentre which is built with the Internet facilities only offer the Internet connection in four kilometers diameter around the telecentre [1]. Therefore, the best approach to provide email services for users who has no internet connection at other areas is by introducing an offline email system. This offline email system using Transmission Control Protocol and Internet Protocol (TCP/IP) with the database synchronization application as a data mule where it works as a network bridge by bringing the pending emails from offline server computer to the online server computer.

TCP/IP has been used widely in the email application as well as in World Wide Web (WWW), File Transfer Protocol (FTP) and Voice-over-IP (VoIP). TCP/IP fundamental assumption is, there is always end-to-end communication between sender and receiver. End-to-end communication means that the network provides a reliable transport layer with immediate data transmission to the receiver and to provide data integrity, delivery guarantees, delivery acknowledgement, duplicate message suppression, per packet encryption and transaction management [2]. However, end-to-end communications cannot be applied in this offline email system because of the rural area is

lack of continuous connection from sender to receiver. TCP/IP drops the packets if the next connection cannot be found immediately. Delay tolerant network (DTN) protocol is used in this thesis to solve this problem. DTN used store and forward operation and introduced a bundle protocol in between the application layer and the transport layer.

Delay tolerant network (DTN) is an approach to computer network to overcome the lack of end-to-end network connectivity. DTN tolerates delay and disruption with acceptable performance in high loss and delay error environments. DTN tries to solve some of the issues by relaxing some of the TCP/IP end-to-end communication assumptions by introducing bundle protocol. The bundle protocol defines a series of data blocks as a bundle. Bundles are routed in Store and Forward operation from source node to the destination node. Store and Forward operation is a DTN fundamentals where it is designed to use storage within the network and perform incremental progress before proceeding to another path.

This thesis focuses on an offline email system implementation in a rural area with some modification to the protocol because it is designed as such the email needs to be transferred to another different device before it can be transmitted. This offline email system is designed for rural users with no internet connection to allow them to access their email account and compose new messages or check the last reply as shown in Figure 1.1. Village A and Village B are located very far from the telecentre, from three kilometers to 40 kilometers. Rural villagers send their emails using their laptop or handphone and send it to the nearby offline mail server. From this offline mail server, the appointed person with infomediary device will collect all the emails from the offline mail server by positioning his infomediary device close to the offline mail server so that the transmission

takes place wirelessly based on wireless local area network (WLAN) based on IEEE 802.11 standards. Conventionally, there is a need of a more internet hotspot datacenter at each village to stay connected which will require a higher cost.

Email application is asynchronous in nature and do not need end-to-end connectivity. Therefore, DTN store and forward fundamental is suitable for use to implement an offline email system in a rural area. In this thesis work, the store and forward process implemented by using file synchronization method. Store and forward process is a technique in which data is sent to an intermediate station and kept temporarily before sent to the final destination or to another intermediate station [3]. The file synchronization process is critical because the offline email on the offline mail server should capable to synchronize its database with the intermediate device and the online mail server. The intermediate device, known as an infomediary device is a temporary storage for the email database. This device collects the emails from the offline environment and brings them to the online environment.

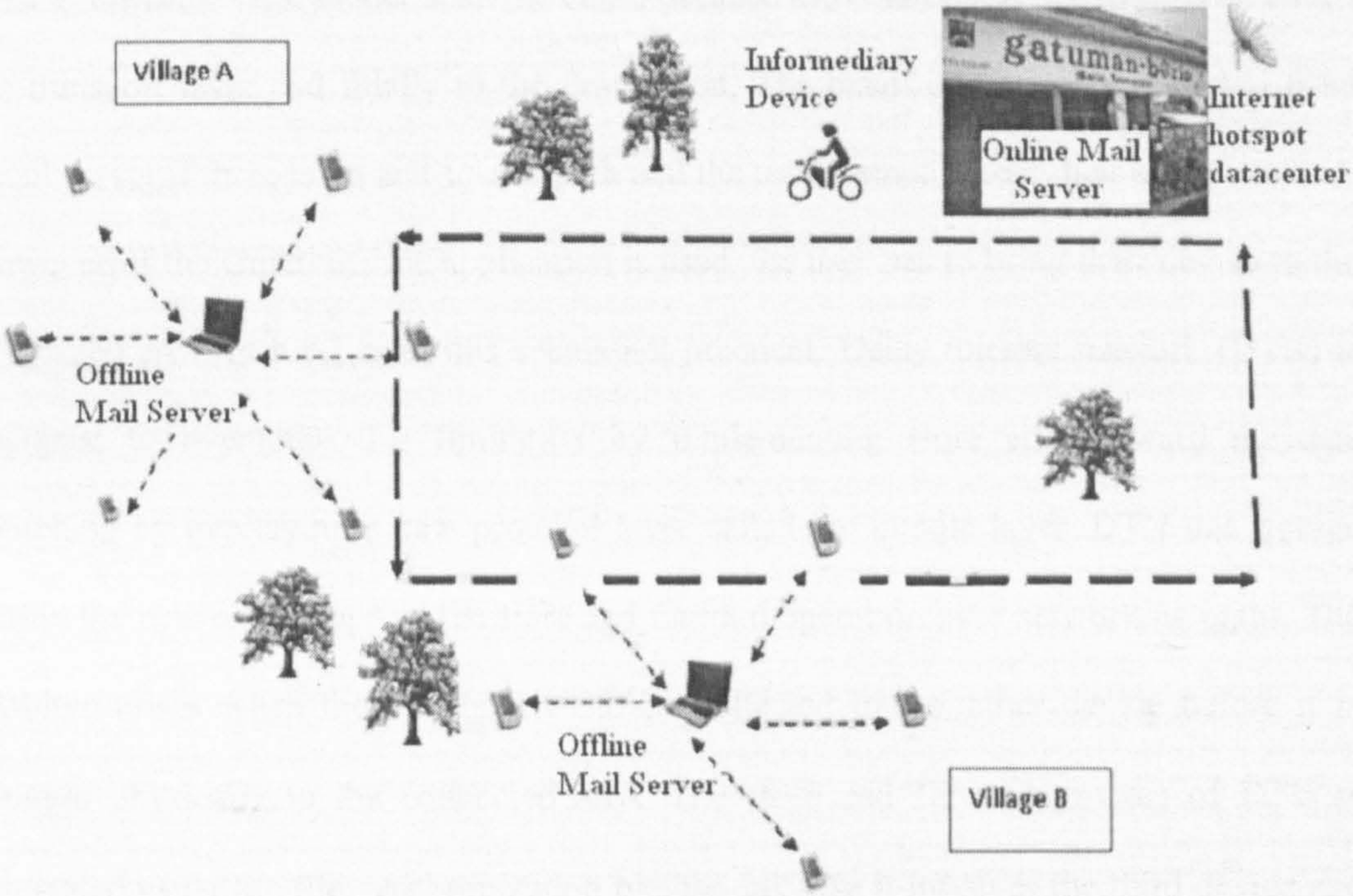

Figure 1.1: Offline email system overview

This offline email system is working in two different environments which is an offline local area network (LAN) environment and online internet environment. Both offline and online mail server running on operating system Windows XP 32bit. Smartphone android 2.3.5 conjunction with *Samba File sharing* application working as an infomediary device to allow receiving and sending files between both mail servers. Only one online mail server is connected to regular Streamyx ISP (Dynamic IP) internet connection instead of the need of a more internet hotspot datacenter at each village.

1.2 Problem Statement

TCP/IP does not fully support this offline email system because it requires immediate end-to-end path between sender and receiver. This means the connection must

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exist at the same time sender send the email because the email packets will travel through the transport layer and finally to the destination. The email client is disconnected from email server if there is no end-to-end path and the user cannot access their email account. However, if the Gmail offline application is used, the user has to bring their device to the connected area. In rural area, this seems not practical. Delay tolerant network (DTN) is designed to overcome this limitation by implementing store and forward message switching by overlaying a new protocol layer called the bundle layer. DTN use storage within the network to support the store and forward operation over networking paths. The problem arises when the emails have to be collected into another device before it is brought physically to the connected area. The store and forward process of DTN is integrated using the file synchronization method because it involves the third device and the third person to bring the emails to the connected area.

1.3 Objective

The objective of this thesis is to provide an offline email system at rural area that has no internet connection. There are three research questions in this thesis as below:

1) Implementation: How the user registration page should be implemented and how the store and forward process in delay tolerant network (DTN) supports the offline email system in terms of email connectivity from the offline environment network to online environment network?
2) Functionality: Can the email data maintain in the mail server for a very long time delay until it synchronized with infomediary device? What is the limitation size of email data which include email content and file attachment?

What are the types of data supported when uploading an attachment? Can the email data synchronization process avoid conflict when the email sent and replied from multiple sender and receiver or when the email sent and replied through multiple communications?

3) Performance: What is the limitation movement speed of an infomediary device when moving through a mail server and performing a database synchronization?

1.4 The Proposed System

An offline mail server in the rural area local area network (LAN) is where rural users can read, send and receive email locally in the LAN. Meanwhile the external email content to be sent online will be stored temporarily until it is transferred to infomediary device. The database synchronization system in the offline server computer will transfer and receive new database from the infomediary device as shown in Figure 1.2. Infomediary device working as a temporary storage and can be accessible via Wi-Fi or wireless local area network (WLAN). Then the database synchronization system in the online server computer will transfer and receive new email data from this infomediary device. Online mail server has all the features as offline mail server where the user in that area can use the offline email system locally through LAN. Online mail server is connected to the internet. This offline email system can be access from the internet through the online mail server. The external email content to be sent offline will be stored temporarily until it is being transferred to infomediary device and then to the offline mail server at rural area.

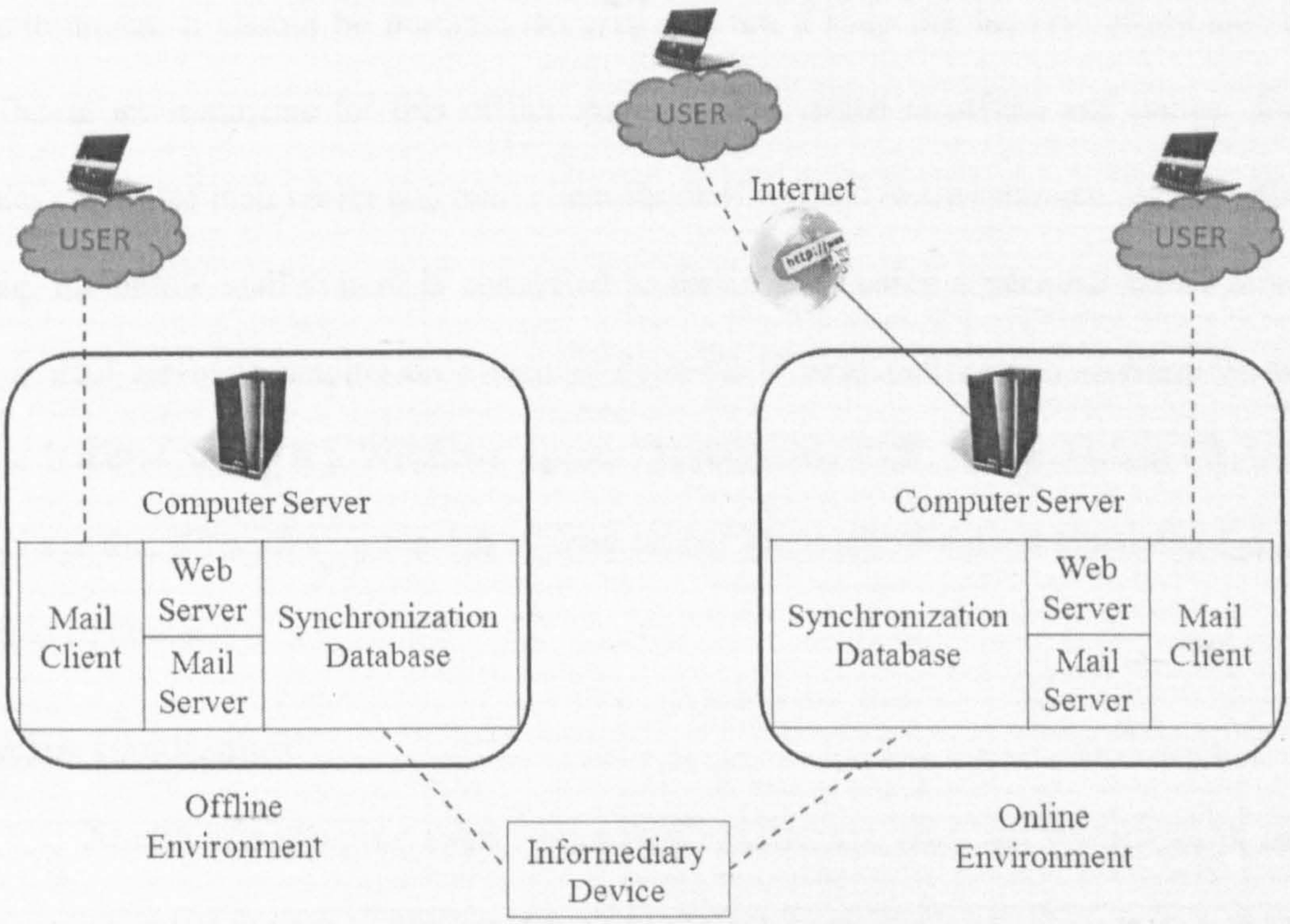

Figure 1.2: Offline email system components

Store and forward process between mail server and infomediary device provide the ability of connection between offline email system and online email system. This will enable the email content to flow through the offline environment to the internet environment and vice versa. It is critical to develop a suitable subsystem that can fulfill the need of this offline email system because there is a challenge in the email database synchronization. This synchronization system should have the ability to synchronize the database between the offline mail server and the infomediary device. It is also responsible to synchronize the database in the online mail server and database in the infomediary device. Infomediary device is a temporary storage for the email database operates wirelessly to collect the email data between the offline environment and the online

environment. It should be portable, secured and has a long life battery. There are two different environments for this offline email system which is offline and online. Both sides consist of mail server and mail client for their respective environment. At the online side, the online mail system is connected to the internet using a personal home server. This mail server is running on Streamyx dynamic IP conjunction with *Uniform Server*. The *Uniform Server* is a Windows Apache, MySQL and PHP, Perl or Python (WAMP) package that allows the user to run a server on any Microsoft Windows Operating System based computer.

1.5 System Implications

At offline mail server, users have a local mail access. They can manage, read, send or receive email locally to another person in the local area network. Infomediary device allows email data to be sent from offline network to online network and vice versa. This extends the offline email system network by allowing user to read, send and receive email in an offline environment or in an online environment. At the online mail server, users also have a local mail access. Since the online mail server is connected to the internet, users able to send and receive email from other Internet Mail such as Gmail and Hotmail directly. With the help of infomediary device, online users can receive or send email to the rural users at the offline mail server. This offline email system is not using native DTN protocol but applies a DTN store and forward fundamentals in TCP/IP by using a database synchronization process.